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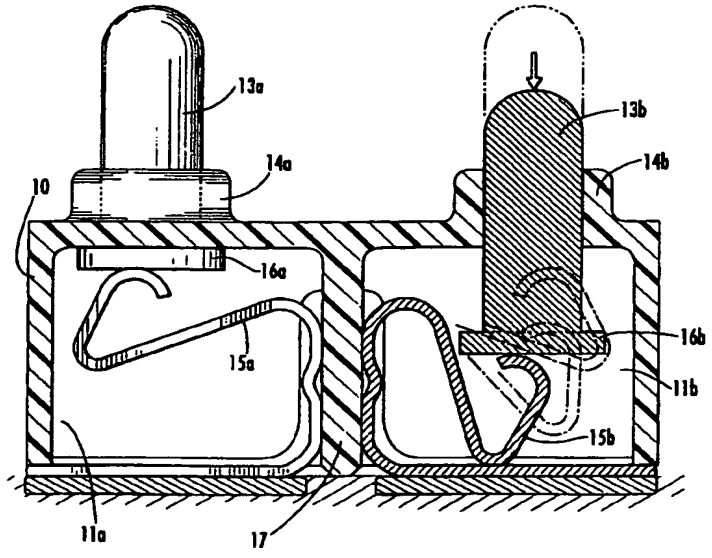
(54) Title: ELECTRICAL CONNECTOR



(57) Abstract: An electrical connector (10) is disclosed with spring-loaded pin connectors having resilient arm members (15a, 15b) providing spring pressure upon pins (13a, 13b) is disclosed. A series of elongated pins (13a, 13b) are extended through a series of openings in the upper or top portion of the housing, the pins being configured for movement into and out of the housing through the opening, wherein a portion of each pin is within the cavity of the housing and a portion of each pin is on the exterior of the housing. Resilient arm members (15a, 15b) with the housing provide flexible springing force upon the bases (16a, 16b) of the pins.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Title of the Invention

Electrical Connector

Cross Reference to Related Applications

Priority is hereby claimed to application U.S. Serial No. 60/235,112 which is a provisional application entitled: "ELECTRICAL CONNECTOR" filed September 25, 2000.

Field of the Invention

The present invention relates to electrical connectors in general, and more particularly to a pin connector employing spring-loaded pins adapted to provide electrical conductivity in an electronic device.

Background of the Invention

Methods and apparatus are known for using pin connector assemblies for electrical applications, such as cellular phone applications and the like. For example, it is known to provide a pin connector that employs a coil spring located at the base of the pin element. The coil spring in such devices is capable of retracting to faciliate the withdrawal of the pin within a hollow recess in the housing when the pin element is axially loaded (i.e.: pressed). Typically, when such loading force is removed, the coil spring elongates, thereby pushing the pin element out of the hollow cavity of the housing to a height sufficient for electrical applications. Such devices typically include coil springs shaped in a conventional helical arrangement, and they provide an upward force to push the pins out of the housing in such connector assemblies.

A concern with the conventional pin connector assemblies that have been used in the past is the ability to reduce the cost associated with manufacturing this type of connector.

Further, the reliability and durability of pin connectors is a very important consideration. Cellular phones and other devices sometimes operate in a vibrating mode, in which the handset vibrates instead of audibly ringing to signal an incoming call to the user. Applications that

employ a vibrating mode of operation sometimes induce significant amounts of stress upon pin type connector assemblies.

It is imperative that the spring employed in pin connector assemblies be durable and capable of operating in a consistent manner. The assembly must be capable of reliable operation over long periods of time under less than ideal physical conditions.

A primary consideration relating to such connectors is that the coil springs sometimes are costly to manufacture. Further, assemblies that employ coil-type springs usually must be hand assembled. When coil springs are used, the coil spring occasionally develops a stress fracture or other material defect within the spring causing the springs to fail or to perform in an inferior manner.

What is needed in the industry is a connector that performs satisfactorily under normal working conditions. Further, a connector that is less expensive to manufacture would be highly desirable. A connector utilizing pins that is more reliable, and can be manufactured into a compact housing, also is very desirable. Connectors employing springs that do not suffer the disadvantages of coil springs would be useful.

Summary of the Invention

One embodiment of the present invention provides a relatively inexpensive and reliable pin connector particularly suited for use in electronic devices. Further, in another aspect, the invention provides a connector that is capable of operating satisfactorily in a vibrating mode application.

In some applications, the invention provides a less expensive and more reliable connector employing a resilient arm member pressing or mating against the base of the pin element.

Additional objects and advantages of the invention will be set forth in part in the following description, or may be learned through practice of the invention.

Further, in one aspect of the invention, a connector is provided comprising a housing having a top, a bottom, and one or more sides, the sides enclosing a cavity within the housing. The housing may be defined by an interior and an exterior. In one embodiment, an opening in the top of the housing provides an elongated pin. The pin may be configured for movement into and out of the housing through the opening, wherein the pin rests in a position such that a portion of the pin is within the cavity on the interior of the housing and a portion of the pin is on the exterior of the housing. Additionally, a resilient arm member is provided within the cavity of the housing, the arm member having a proximal end and a distal end. In general, the distal end is adapted for pressing engagement with the elongated pin, the proximal end of the resilient arm member being secured on the interior of the housing.

A connector is also provided wherein the housing is subdivided into a plurality of cavities adapted to hold one or more resilient arm members and one or more pin elements in contact with each other. A connector is provided in which an opening comprises a cylindrical hole extending between the exterior of the housing and the interior of the housing, wherein a pin is capable of reciprocating (i.e.: back and forth) movement within the cylindrical hole. The connector also may include a rim that is adapted to support the pin.

In one aspect of the invention, a connector is provided in which the pin comprises a distal end and a proximal end, the proximal end of the pin being secured within the housing by a retaining portion.

In one embodiment, the invention provides a pin having a retaining portion with a larger diameter than the opening in the top of the housing, such that the retaining portion secures the proximal end of the pin on the interior of the housing.

A connector is also provided as one embodiment of the invention in which the resilient arm member is elongated and flexible. In some applications, the resilient arm member of the connector

pushes on the proximal end of the pin, thereby providing a relatively constant spring force upon the pin.

In one embodiment of the invention, a spring pin connector is provided comprising a housing having a top, a bottom and one or more sides, the sides enclosing a cavity within the housing, the housing being further defined by an interior and an exterior. In some instances, a plurality of openings in the top of the housing are provided. Further, a plurality of elongated pins may be configured for movement into and out of the housing through the openings. The pins may further comprise a proximal end within the interior of the housing and a distal end on the exterior of the housing.

In another embodiment of the invention, a plurality of resilient arm members provide a proximal end and a distal end, the distal end of said arm members being adapted for pressing engagement with the elongated pin.

In some applications, a pin connector is provided having at least four pins within the housing. A pin connector is also provided having cavities within the housing that include, at spaced intervals along a side of the housing, at least one resilient arm member within the cavity. Further, the connector includes overlapping cavities separated by at least one divider element. The resilient arm members also may comprise curved tips on their distal end, the curved tips being adapted for pressing engagement to the proximal end of said pins. Further, the pin connector may be bullet-shaped on its distal end. In some aspects of the invention, the pin connector is provided in a paired configuration along the length of the housing.

Brief Description of the Drawings

The present invention will be more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, and in which:

Figure 1 is a cross-sectional view of a prior art pin connector using coil springs within the housing for engagement against the underside of the pins;

Figure 2 depicts a perspective view of one embodiment of the pin connector of the invention;

Figure 3 is a cross-sectional view of one embodiment of the pin connector taken along lines 3-3 as shown in Figure 2;

Figure 4 shows a side view of one embodiment of the pin connector;

Figure 5 is a top view of the pin connector shown in Figure 4;

Figure 6 details a side operational view of one embodiment of the pin connector with an expanded housing taken along the lines 6-6 of Figure 4;

Figure 6A details a side operational view of another alternate embodiment of the pin connector;

Figure 7 provides a top view of an alternate embodiment of the pin connector having five sets of pins in two elongated rows; and

Figure 8 is a top view of still another embodiment of the pin connector having 7 sets of pins in two elongated rows.

Detailed Description of the Invention

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope and spirit of the invention. It is intended that the present invention include such modifications and variations as come within the scope of the appended claims and their equivalents.

Several embodiments of the invention are shown. Turning to Figure 2, a perspective view of a pin connector is shown. Both pins, 13a and 13b, are in their normal and fully extended positions when no axial load is applied. The housing 10 is shown in a rectangular shape. Rims 14a and 14b represent the cylindrical extensions from the housing 10.

Figure 3 is a cross-sectional view of Figure 2 along the lines 3-3. As illustrated, pin 13b is axially loaded as shown in Fig. 3 while pin 13a is not. In this embodiment both cavities 11a and 11b are adjacent and share a common divider element 17. The resilient arm members 15a and 15b rest on the floor of the housing 10. Both resilient arm members 15a and 15b are braced by the divider element 17. The base portion 16a of pin element 13a is shown pressed to the top of the hollow section 11a when in the non-axially loaded position by resilient arm member 15a. Resilient spring members 15a and 15b are shown extended within the housing, held at their proximal end on the housing wall. However, numerous other arrangements for contacts are possible, and the resilient spring members 15a and 15b could be held at any point within the housing. The resilient spring members 15a and 15b are curved in at least two or three points of curvature, and then biased against the proximal end of the pins 13a and 13b.

One advantage of resilient arm members 15a-b is that they facilitate a longer stroke of the pins into and out of the housing, by allowing the pins to come farther into the housing. Thus, pin 13b is able to retract about one-half or more of its length into the housing, which can be a significant advantage offering design flexibility and the potential for miniaturization.

The resilient arm members 15a-b as shown in Figure 3 rest against the bearing surfaces of the divider element as shown along the mid-line of the Figure 3. The arm members 15a-b may have one, two, three or more curves along their length that provide a springing action by tension imparted by the metal upon the proximal end of the pins. A curved tip on the end of the resilient arm members 15a-b bears against the pins, as shown in Figure 3, to provide an upward springing force. The pins, on their distal end, may be bullet-shaped to facilitate convenient entry into a female type electrical terminal.

Figure 4 is a side view of still another embodiment of the pin connector showing the relative height of the cylindrical rims 14a and

14b and the non-axially loaded pin elements 13a and 13b. In Figure 4, the housing is wider to accommodate staggered resilient arm members along its length, as further discussed below.

Figure 5 shows a top view of the pin connector illustrating the relative diameters of the cylindrical rims 14a and 14b and the pins 13a and 13b. This view also illustrates the rectangular shape of the housing 10.

Other embodiments could use pins having different lengths, and some applications might require a set of short pins, and a set of long pins, for example. Further, it might be advantageous to use various arrangements of resilient arm members, and sometimes it may be useful to use resilient arm members in combination with coil or compression springs to achieve a particular technical feature or size requirement within the housing. Also, using a combination of compression springs and resilient arm members may provide for an efficient use of space within a rectangular housing. However, resilient arm members generally believed to be quite useful for most embodiments of the invention.

Another embodiment of the invention illustrated in Figure 6 shows the cross-sectional view of Figure 4 cut along the line 6-6. This embodiment provides offset divider elements 18, which allow the cavities 11a and 11b to be elongated. The elongated hollow sections 11a and 1b facilitate the employment of more versatile resilient arm members 15a and 15b. The resilient arm members 15a and 15b are long, allowing more room for these structures to bend within the cavities 11a and 11b. The cavities 11a and 11b may be roughly rectangular in the case of a two pin connector, or may be elongate in the case of multi-pin connectors. This results in pin elements 13a and 13b having a lower profile within the housing 10 and cylindrical extensions 14a and 14b than in other embodiments. Further, the resilient arm members may comprise overlapping cavities as shown in Figure 6, wherein the lateral space occupied by each resilient arm

member is staggered along the length of the housing. This arrangement provides for a longer beam length along the sections of the resilient arm members.

Figure 6A shows yet another embodiment of the invention with a different contact arrangement inside the housing. This particular embodiment shows offset divider element 118, which serves to separate cavities 110a and 110b. Resilient arm members 115a and 115b are shown engaging the lower surface of the pin elements 113a and 113b, respectively. In this alternative embodiment, a more efficient utilization of the space within the housing may be obtained. As shown in Figure 6A, the cavities 110a and 110b are roughly rectangular. Furthermore, cylindrical extensions 114a and 114b provide a profile for the upper portion of the housing. The base of the connectors includes base stops 116a-b, which provide a bearing surface for the curved tips 112a and 112b of the resilient arm members 115a and 115b, respectively.

Figures 7 and 8 represent two particular embodiments of the pin connector. Depending upon the application, pin connectors 14 having any number of pin elements may be employed. Cylindrical rims 14 a-j and pin elements 13 a-n are shown. There is generally no limit to the number of connectors that may be provided in the practice of the invention. Figure 7 shows five pairs of pin connectors, having pins 13a-n and 14a-n. Figure 8 shows seven pairs of connectors. This represents two examples of how the invention can be employed. The resilient arm members may be staggered along the length of the housing. It should be understood that the number of pin elements 13 a-n will vary depending on the application, and there is no limit to the number that may employed. Pin connectors can be provided in rows of three, four, five or more as well. Further, pin connectors can be used as a roughly square grid, with for example, a 3X3, 4X4, 5X5, or other combination of connectors in a grid could be employed.

It is understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only, and is not

intended as limiting the broader aspects of the present invention, which broader aspects are embodied in the exemplary constructions. The invention is shown by example in the appended claims.

We Claim:

1. A connector comprising,

(a) a housing having a top, a bottom, and a plurality of sides, the sides enclosing a cavity within the housing, the housing being defined by an interior and an exterior;

(b) an opening in the top of the housing;

(c) at least one elongated pin, the pin being configured for movement into and out of the housing through the opening, wherein the pin is provided in a position such that a portion of the pin is within the cavity of the housing and a portion of the pin is on the exterior of the housing; and

(d) a resilient arm member within the cavity of the housing, said resilient arm member having a proximal end and a distal end, the distal end being adapted for pressing engagement with the elongated pin, the proximal end of the resilient arm member being secured on the interior of the housing.

2. The connector of claim 1 wherein the housing further includes a plurality of cavities adapted to hold one or more resilient arm members and one or more pin elements in contact with each other.

3. The connector of claim 1 wherein the opening comprises a cylindrical hole extending from the exterior of the housing to the interior of the housing, wherein the pin is adapted for reciprocating movement within the cylindrical hole.

4. The connector of claim 1 wherein the connector further comprises a rim adapted to support the pin.

5. The connector of claim 1 wherein the pin comprises a distal end and a proximal end, the proximal end of the pin being secured within the housing by a retaining portion.

6. The connector of claim 5 wherein the retaining portion provides a larger diameter than the opening in the top of the housing, such that the retaining portion secures the proximal end of the pin in the interior of the housing.

7. The connector of claim 1 wherein the resilient arm member is elongated and flexible along its length.

8. The connector of claim 5 wherein the resilient arm member is capable of applying force to the proximal end of the pin, thereby providing a relatively constant force upon the pin.

9. A spring pin connector comprising:

(a) a housing having a top, a bottom and one or more sides, the sides enclosing a cavity within the housing, the housing being defined by an interior and an exterior;

(b) a plurality of openings in the top of the housing;

(c) a plurality of elongated pins, the pins being configured for movement into and out of the housing through said openings, wherein said pins further comprise a proximal end within the interior of the housing, and a distal end on the exterior of the housing; and

(d) a plurality of resilient arm members within the cavity of the housing, each arm member having a proximal end and a distal end, the distal end being adapted for pressing engagement with the elongated pin, the proximal being secured on the interior of the housing.

10. The pin connector as in claim 9 in which the housing comprises a generally rectangular shape, the housing having a plurality of internal cavities in which at least one resilient arm members is located, said resilient arm member being held in springing engagement with a pin.

11. The pin connector of claim 9, wherein at least one pin is capable of longitudinal reciprocation in to and out of the housing, said pin having a retaining means on its proximal end adapted to retain the proximal end of the pin within the housing.

12. The connector of claim 9 further comprising a housing having a rim extending from the top of the housing, said rim adapted to provide support for at least one pin to facilitate movement of said pin in the opening.

13. The pin connector of claim 9 comprising at least three pins within the housing.

14. The pin connector of claim 9, wherein at least four pins are provided within the housing.

15. The pin connector of claim 9, wherein cavities within the housing are provided at spaced intervals along a side of the housing, each cavity comprising at least one resilient arm member within the cavity, the connector having overlapping cavities separated by at least one divider element.

16. The pin connector of claim 9 wherein the resilient arm members further comprise bearing surfaces, said bearing surfaces being held in contact with said divider element.

17. The pin connector of claim 9 wherein the resilient arm members comprise flexible springs.

18. The pin connector of claim 9 wherein the resilient arm members comprise curved tips on their distal end, the curved tips being adapted for pressing engagement to the proximate end of said pins.

19. The pin connector of claim 9 in which at least one pin is bullet-shaped on its distal end.

20. The pin connector of claim 9 in which the pins are provided in a paired configuration along the length of the housing.

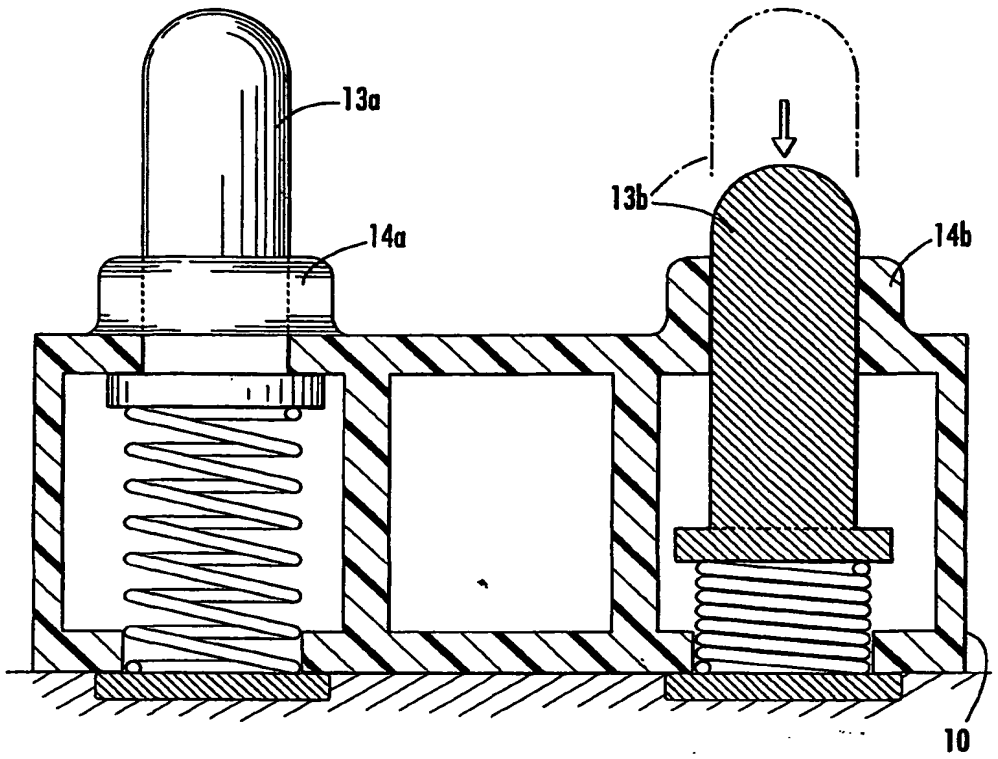


FIG. 1.
(PRIOR ART)

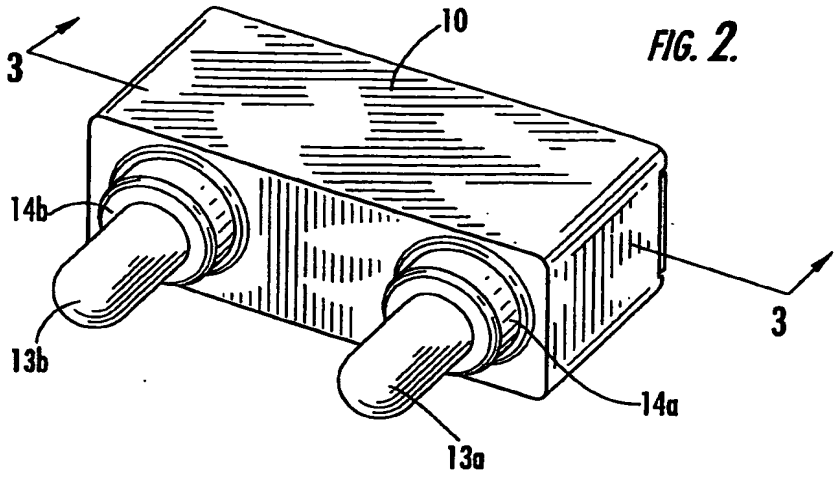
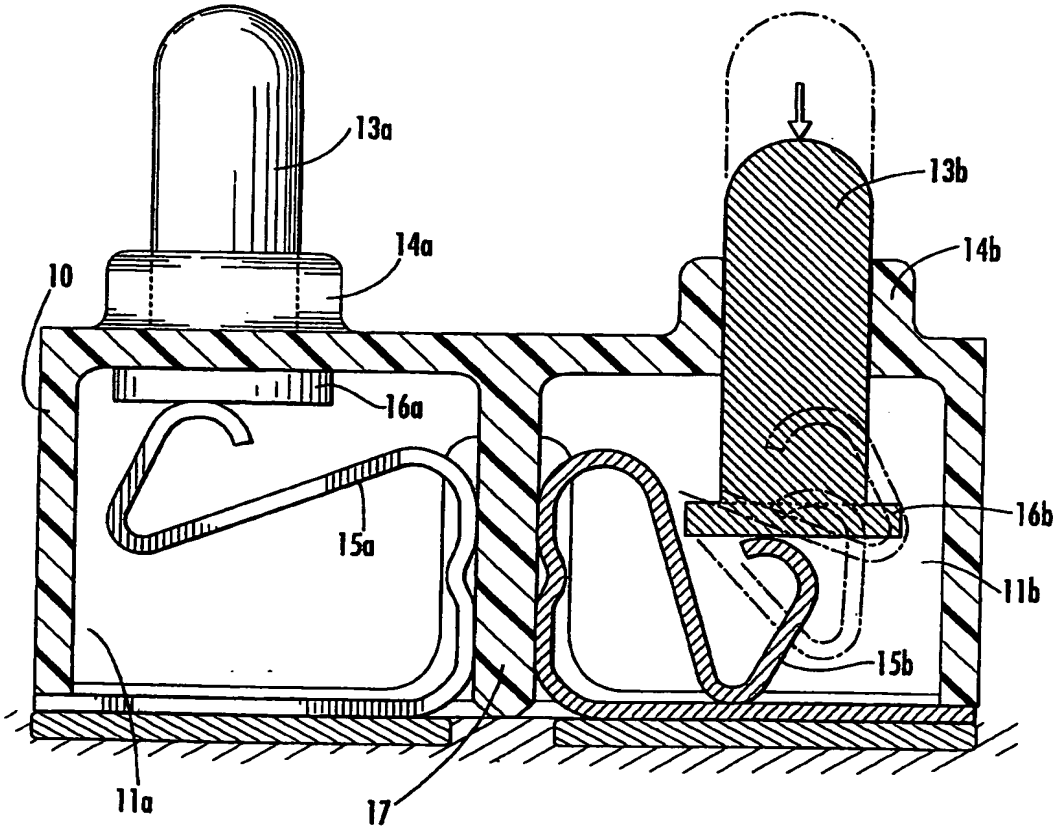

10
3
3
14b
13b
14a
13a

FIG. 2.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14b
10
16a
16b
15a
11b
15b
11a
17

FIG. 3.

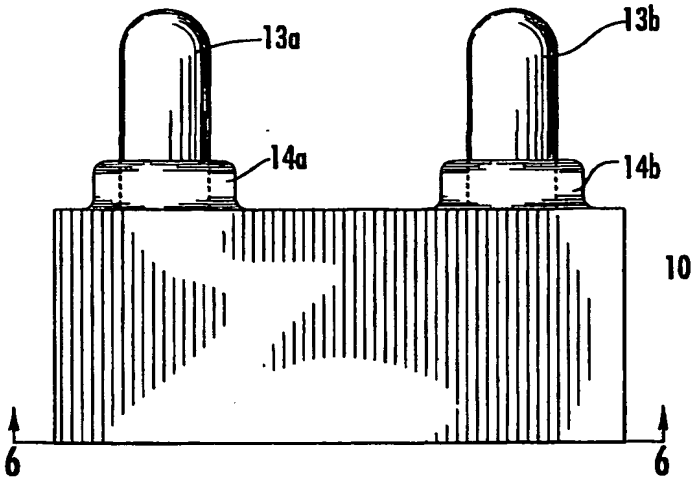


FIG. 4.

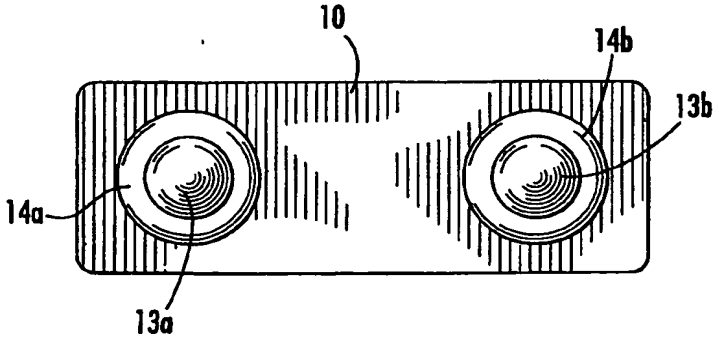


FIG. 5.

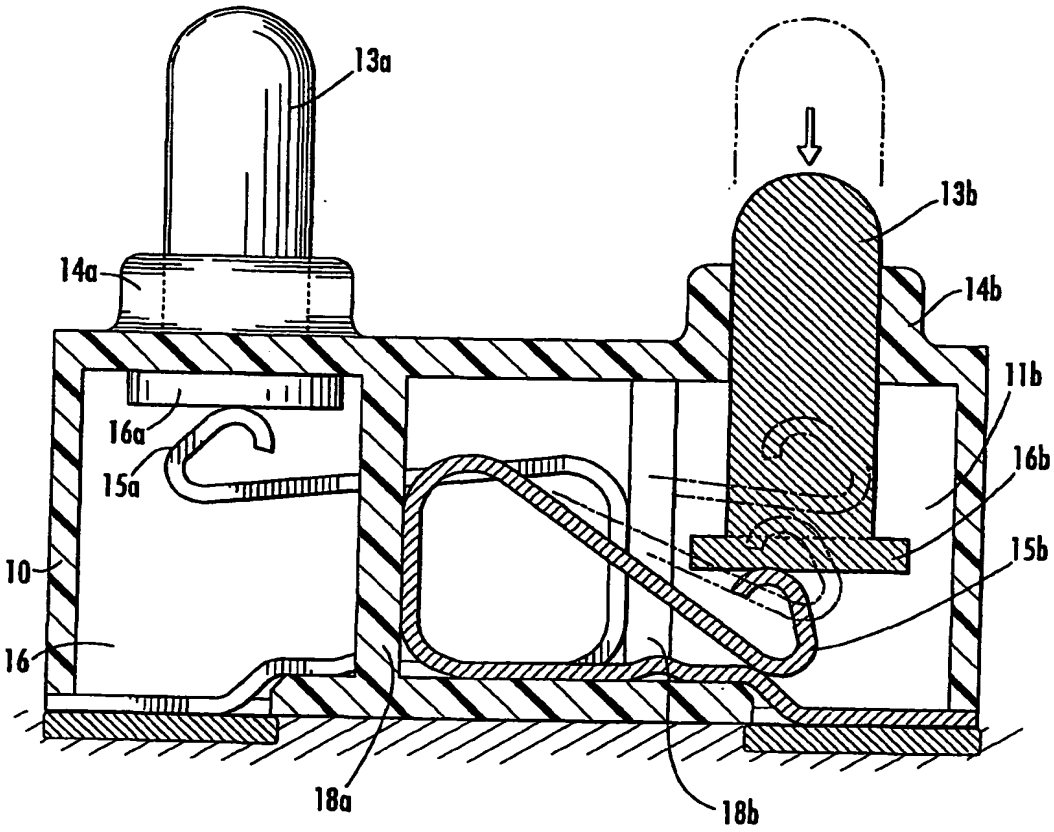
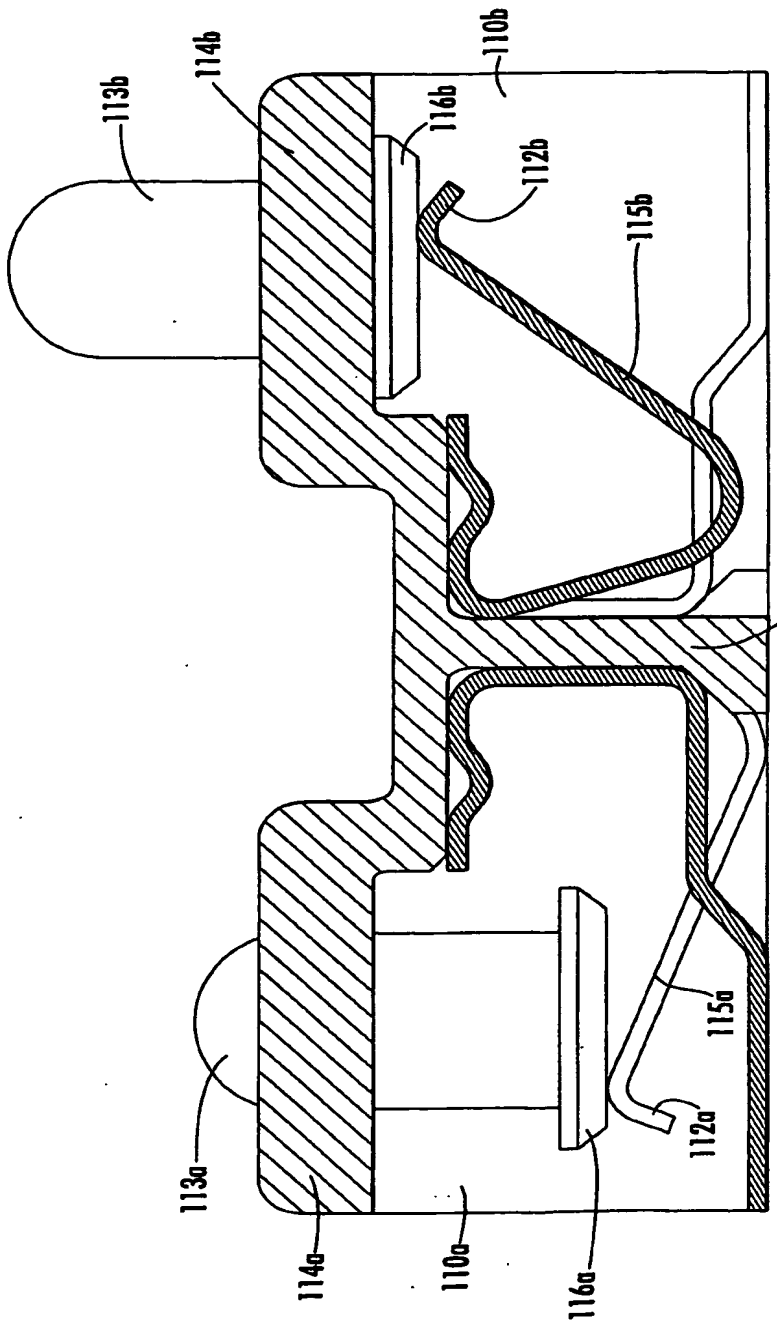


FIG. 6.


113b
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116b
112b
115b
118
115a
112a
113a
114a
110a
116a

FIG. 6A.

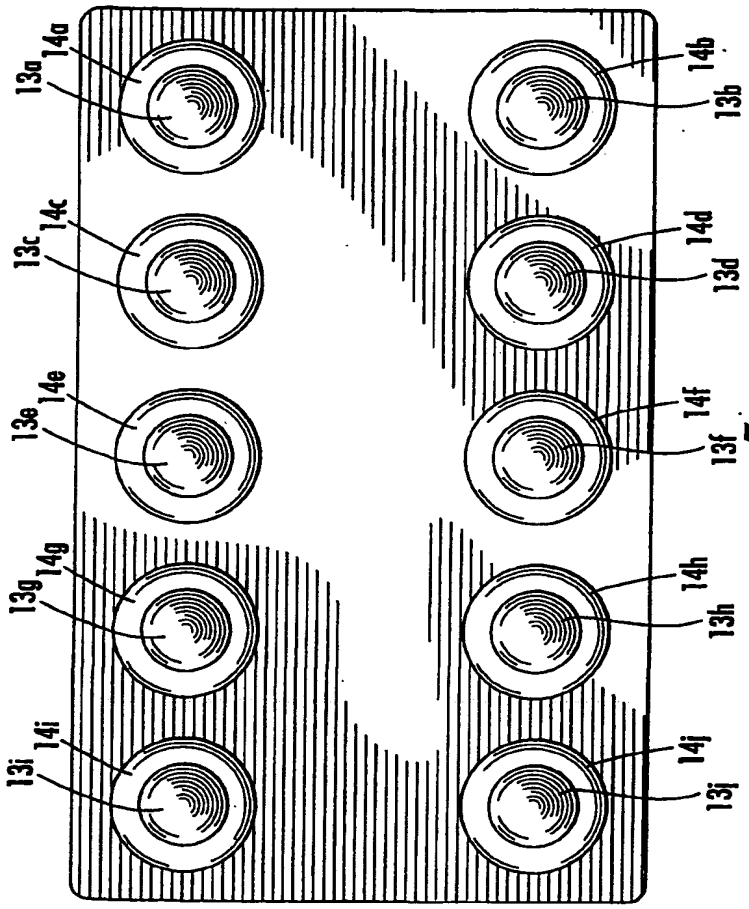
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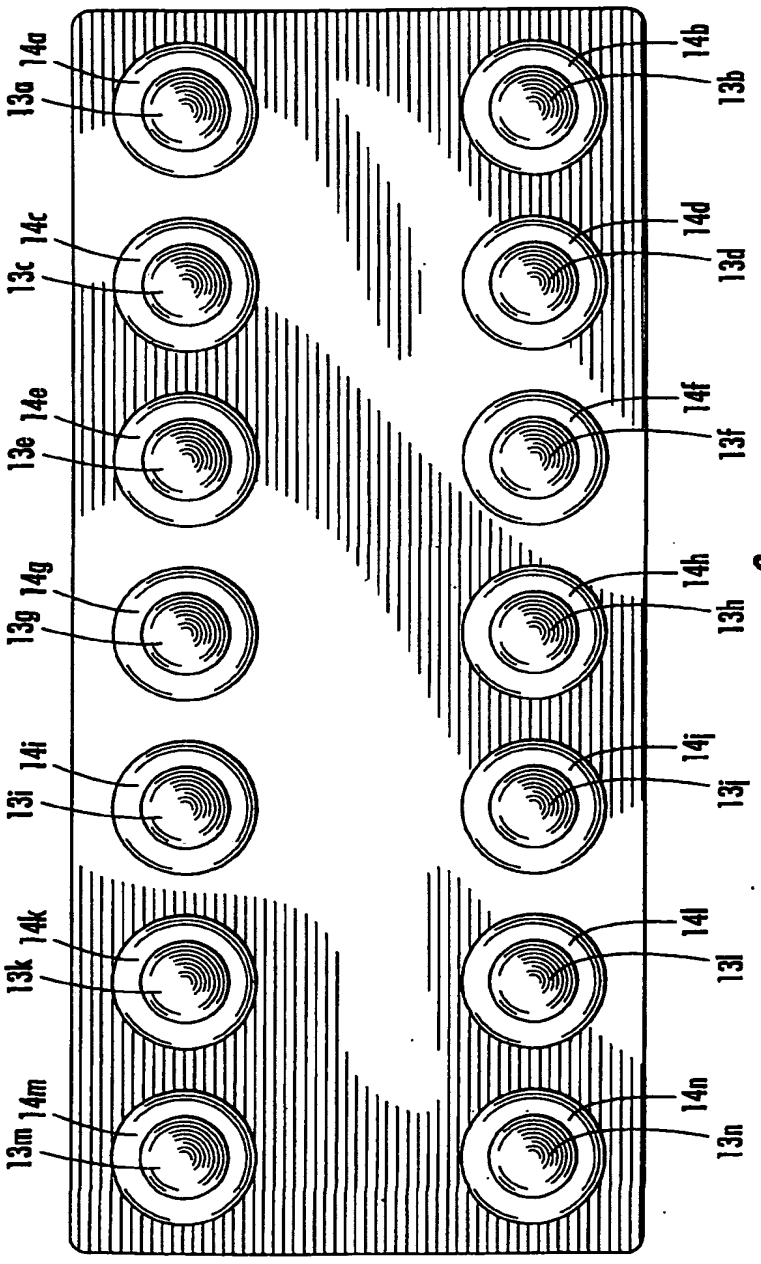
FIG. 7.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14l
13l
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14n
13n

FIG. 8.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/29574

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : H01R 13/64
US CL : 439/247
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 439/247, 219, 482, 700, 824; 200/52r, 250

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,317,969 A (RIEGLER et al) 02 March 1982 (02.03.1982), figures 1 and 4.	1-20
Y	US 5,980,335 A (BARBIERI et al) 09 November 1999 (09.11.1999), figures 1, 2, and 5.	1-20
Y	US 5,664,973 A (EMMERT et al) 09 September 1997 (09.09.1997), figure 2b.	1-20
A,P	US 6,288,458 B1 (BERNDT) 11 September 2001 (11.09.2001), figure 1.	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
27 November 2001 (27.11.2001)

Date of mailing of the international search report
26 DEC 2001

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